Active Project (2016 - 2017)

# Bi-Metallic Additive Manufacturing Close-Out of Coolant Channels for Large Liquid Rocket Engine (LRE) Nozzles, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

## ABSTRACT

This NASA sponsored STTR project will investigate methods for close-out of large, liquid rocket engine nozzle, coolant channels utilizing robotic laser and pulsed-arc additive manufacturing methods. Copper to Nickel alloy interface strength will be quantified and metallurgical characterization completed. A thermal model based on Rosenthal?s analytical expression for a moving heat source, which has been incorporated into a numerical model with provision for adding mass, will be used to predict thermal profiles for AM of the close out. The model will be verified and validated for different material combinations investigated in this study. Keystone will also investigate high temperature stability of the interface Cu-to-Ni layer through thermal treatments. After application of Ni layers and the thermal treatments at varying temperature and times, X-ray diffraction (XRD) will be used to document phases present and analyzed for formation of potential detrimental effects.

## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: Potential NASA applications include large liquid rocket engine combustion chambers and nozzles. Proposed process will enable elimination of current electrochemical plating methods for close out cooling channels in regeneratively cooled components utilized in liquid rocket engines. This technology has the potential to offer significant cost and time reductions for manufacturing of these types of components.

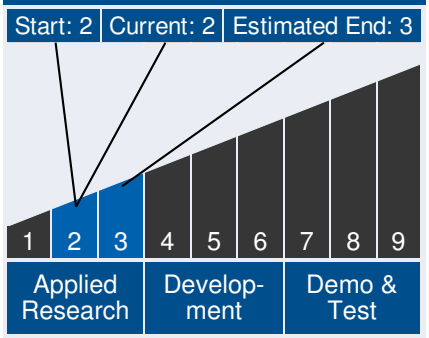
### To the commercial space industry:

Potential Non-NASA Commercial Applications: Potential Non-NASA applications include large liquid rocket engine combustion chambers and nozzles


### Table of Contents



### Technology Maturity




### Management Team

**Program Executives:**

- Joseph Grant
- Laguduva Kubendran

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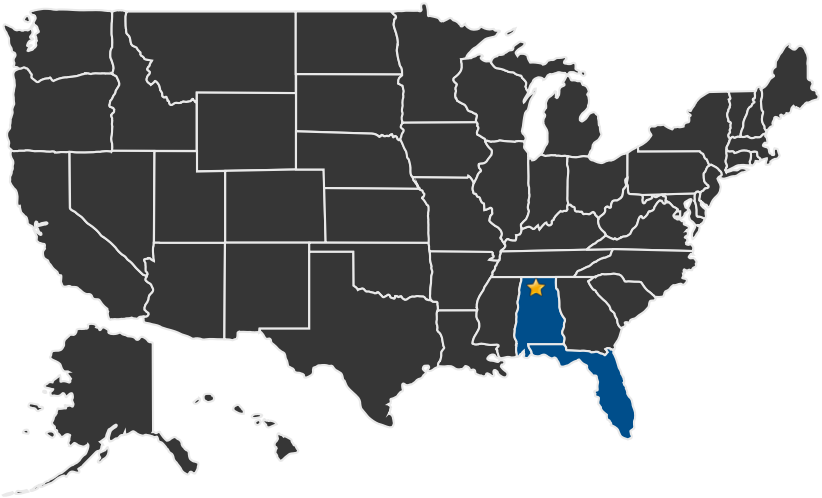
## U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

**Lead Center:**
Marshall Space Flight Center

**Other Organizations Performing Work:**

- Keystone Synergistic Enterprises, Inc.  (Port Saint Lucie, FL)
- University of Alabama at Hunstville  (Huntsville, AL)

## PROJECT LIBRARY

### Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23605)

## Management Team *(cont.)*

**Program Manager:**

- Carlos Torrez

**Principal Investigator:**

- Bryant Walker

## Technology Areas

**Primary Technology Area:**
Materials, Structures, Mechanical Systems and Manufacturing (TA 12)
└ Manufacturing (TA 12.4)
  └ Manufacturing Processes (TA 12.4.1)

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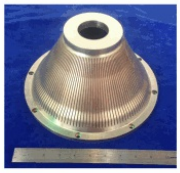
## IMAGE GALLERY



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## DETAILS FOR TECHNOLOGY 1

### Technology Title

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### Potential Applications

Potential NASA applications include large liquid rocket engine combustion chambers and nozzles. Proposed process will enable elimination of current electrochemical plating methods for close out cooling channels in regeneratively cooled components utilized in liquid rocket engines. This technology has the potential to offer significant cost and time reductions for manufacturing of these types of components.